

GP PLAYBOOK

Thematic Goal:

Deliver Modernized Military and Civil GPS Capabilities

IMPLEMENT M-CODE
AVAILABLE FOR USE
(4QF415)

GPE

DELIVER BLOCK 0
FOR GPS III LAUNCH
(2QC416)

GPG

AWARD GPS III
CONTINGENCY OPS CONTRACT
(2QF416)

GPG

EXECUTE OCK BLOCK 1
TO SCP BASELINE

GPG

CERTIFY AT LEAST ONE
MGUE COMPONENT
FOR PRODUCTION
(2QF416)

GPV

COMPLETE FLYOUT
OF ALL GPS III SVs
(3QF416)

GPV

DELIVER GPS III SV-01
AVAILABLE FOR LAUNCH
(4QF416)

GPV

AWARD PHASE I GPS III
FOLLOW-ON PRODUCTION
(2QF416)

GPV

Defining Objective:

Become the Gold Standard Program!

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Space and Missile Systems Center



Global Positioning System Directorate

GPS Update
Partnership Council 2015

29 Apr 2015

Brig Gen Bill Cooley
Director, Global Positioning Systems Directorate

Global Positioning Systems Directorate

SPACE AND MISSILE SYSTEMS CENTER

Mission:

Acquire, deliver and sustain reliable GPS capabilities to America's warfighters, our allies, and civil users



From left to right, a GPS IIA, IIR, and IIF satellite



BGen Bill Cooley
Director



2SOPS Ground Control
(Schriever AFB)

GPS Overview

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Civil Cooperation

- 1+ Billion civil & commercial users
- Search and Rescue
- Civil Signals
 - L1 C/A (Original Signal)
 - L2C (2nd Civil Signal)
 - L5 (Safety of Life)
 - L1C (International)



39 Satellites / 31 Set Healthy
Baseline Constellation: 24 Satellites

| Satellite Block | Quantity | Average Age | Oldest |
|-----------------|----------|-------------|--------|
| GPS IIA | 3 | 21.5 | 24.4 |
| GPS IIR | 12 | 13.3 | 17.7 |
| GPS IIR-M | 7 | 7.7 | 9.6 |
| GPS IIF | 9 | 1.8 | 4.9 |
| Constellation | 31 | 9.5 | 24.4 |

AS OF 20 APR 15

Department of Defense

- Services (Army, Navy, AF, USMC)
- Agencies (NGA & DISA)
- US Naval Observatory
- PNT EXCOMS
- GPS Partnership Council

Maintenance/Security

- All Level I and Level II
 - Worldwide Infrastructure
 - NATO Repair Facility
- Develop & Publish ICDs Semi-Annually
 - ICWG: Worldwide Involvement
- Update GPS.gov Webpage
- Load Operational Software on over 970,000 SAASM Receivers
- Distribute PRNs for the World
 - 120 for US and 90 for GNSS

International Cooperation

- 56 Authorized Allied Users
 - 25+ Years of Cooperation
- GNSS
 - Europe - Galileo
 - China - COMPASS
 - Russia - GLONASS
 - Japan - QZSS
 - India - IRNSS



Spectrum

- World Radio Conference
- International Telecommunication Union
- Bilateral Agreements
- Lightsquared

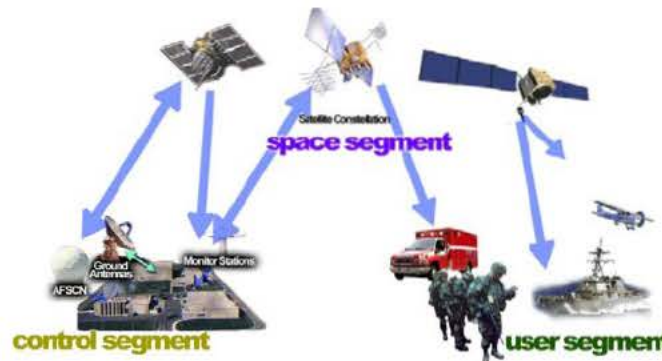


Department of Transportation

- Federal Aviation Administration

Department of Homeland Security

- U.S. Coast Guard





GPS Constellation Status

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31 Operational Satellites (Baseline Constellation: 24+3)

- Robust operational constellation
 - 3 GPS IIA – L1 C/A, L1 P(Y), L2 P(Y) signals
 - 12 GPS IIR – same signals as IIA
 - 7 GPS IIR-M – adds L2C, L1M, L2M signals
 - 9 GPS IIF – adds L5 signal
- 7 additional satellites in residual/test status
- Modified Battery Charge Control has extended GPS IIR and IIR-M life by 1-2 years per SV
- Global GPS civil service performance commitment met continuously since Dec 1993 (IOC)
 - Best performance 43.8 cm User Range Error (URE) 1 Jan 15; best weekly average 52.7 cm URE 23 Nov 14; rolling quarter (as of 15 Apr 15) 59.6 cm
 - Performance improving as new satellites replace older satellites





Accuracy: Military Commitments

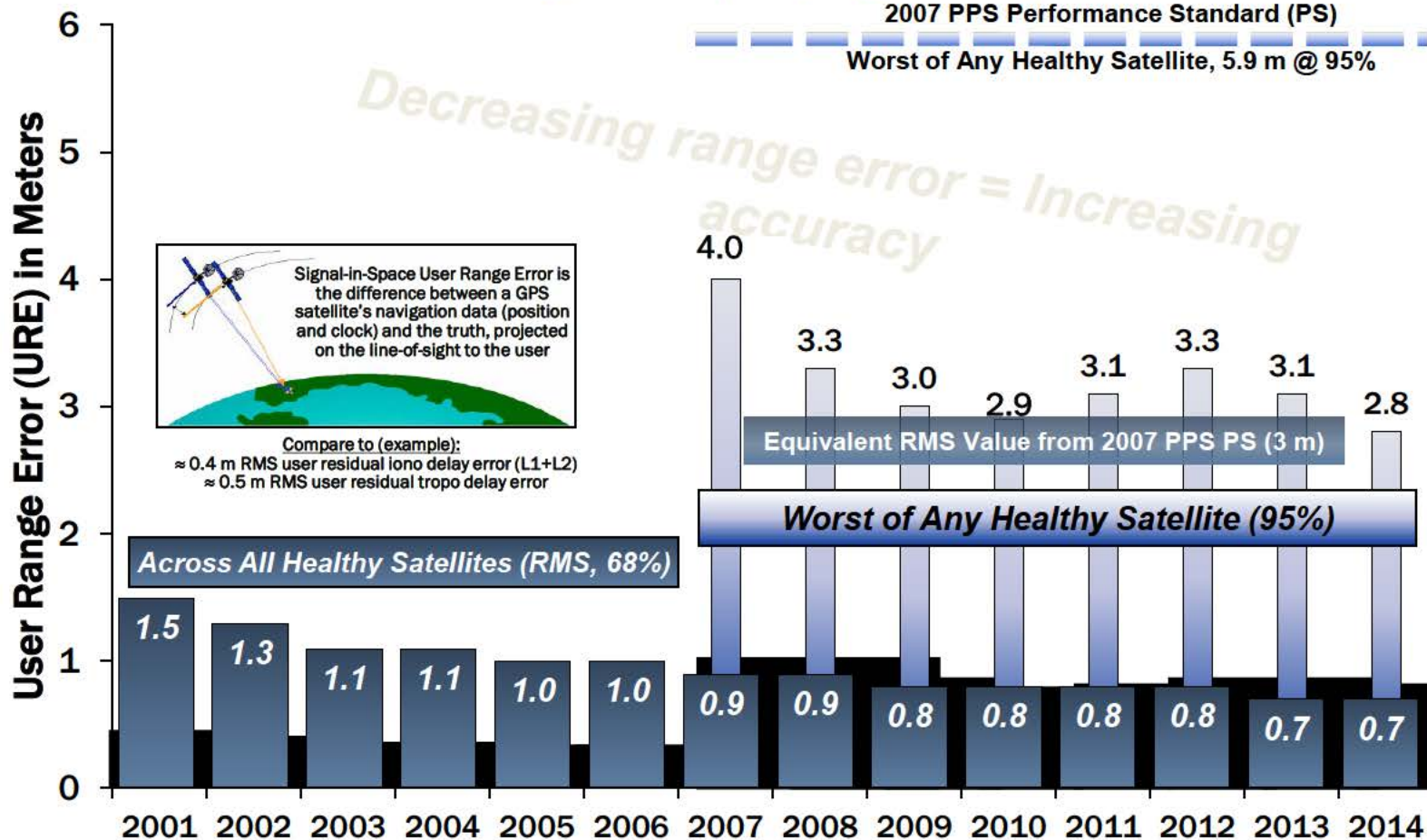
Precise Positioning Service (PPS) Performance Standard

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Precise Positioning Service (PPS) Signal-in-Space Performance

2007 PPS Performance Standard (PS)

Worst of Any Healthy Satellite, 5.9 m @ 95%



System accuracy better than published standard

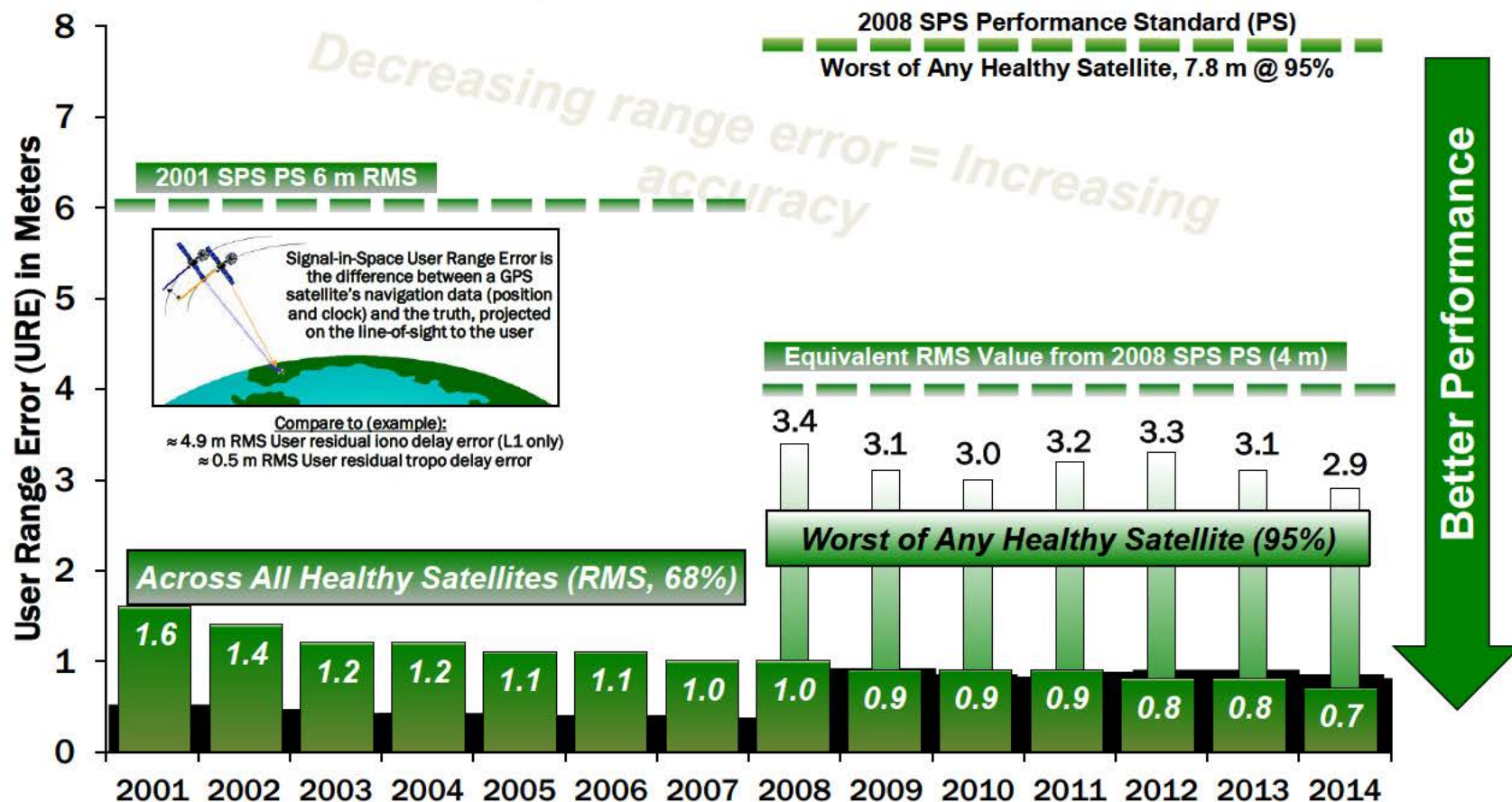


Accuracy: Civil Commitments

Standard Positioning Service (SPS) Performance Standard

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Standard Positioning Service (SPS) Signal-in-Space Performance



System accuracy better than published standard



GPS Modernization Program

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Legacy GPS IIA/IIR

- Single Frequency (L1)
- Coarse acquisition (C/A) code
- Y-Code (L1Y & L2Y)

GPS IIR-M

- 2nd Civil Signal (L2C)
- M-Code (L1M & L2M)

GPS IIF

- 3rd civil signal (L5)
- 2 Rb + 1 Cs Clocks
- 12 year design life

GPS III

- 4th civil signal (L1C)
- 4x better User Range Error than GPS IIF
- Increased availability
- Increased integrity
- 15 year design life



Legacy Operational Control Segment (OCS)

- Mainframe system
- Command & Control
- Signal monitoring

Architecture Evolution Plan (AEP)

- Distributed architecture
- Increased signal monitoring
- Security
- Accuracy
- Launch and disposal ops

Next Generation Operational Control System (OCX) Block 0

- Launch & On-Orbit Checkout of GPS III

OCX Block 1

- Transition to OCX for all GPS command and control operations

Increasing system capabilities - Increasing user benefit

GPS IIF Status

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- 9 total GPS IIFs on-orbit
- 3 more GPS IIFs in the pipeline
 - SVs 9 and 12 are in storage
 - GPS IIF-10 (SV 11) Launch Scheduled for 16 Jun 15



16 May 14: IIF-6

SVN 66 thru 69



1 Aug 14: IIF-7



29 Oct 14: IIF-8



25 Mar 15: IIF-9



GPS III Status

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- Newest block of GPS satellites
 - 4 civil signals: L1 C/A, L1C, L2C, L5
 - First satellites to broadcast common L1C signal
 - 4 military signals: L1/L2 P(Y), L1/L2M
 - Three improved Rubidium atomic clocks
- Received approval to procure SV09/10 under current Lockheed contract
- Navigation panel delivered 1 Nov 14
- Mission Data Unit delivered 9 Mar 15
- SV01 System Module Core Mate completed 9 Apr 15
- GPS III SV01 available for launch Aug 2016



Lockheed-Martin (Waterton, CO) – Prime



Ground Segment Status

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- Current system Operational Control Segment (OCS)
 - Flying GPS constellation on Architecture Evolution Plan (AEP) and Launch & early orbit, Anomaly, and Disposal Operations (LADO) software systems
 - Cyber security enhancements in progress
- Next Generation Operational Control System (OCX)
 - Modernized command & control system with M-Code, modern civil signal monitoring, info assurance infrastructure & improved PNT performance: Raytheon (Aurora, CO) - Prime
 - Successfully completed four GPS III launch exercises
 - OCX Block 0 supports launch & checkout for GPS III; currently in integration & test; delivery expected May 2016
 - OCX Block 1 supports transition from OCS in 2019
 - Civil Signal Performance Monitoring capability scheduled for OCX Block 2 in 2020



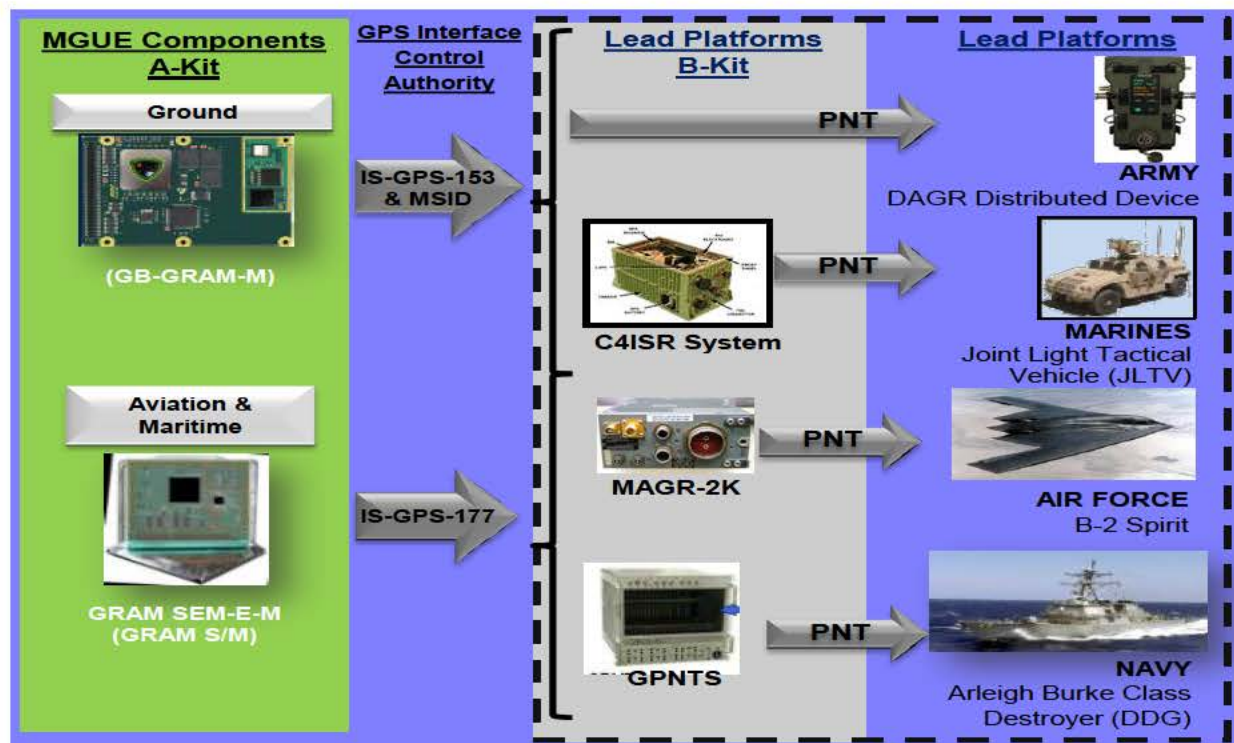
Monitor Station



Ground Antenna

Military User Equipment Status

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- Commercial market driven acquisition approach
- Accelerated from TD phase into testing and lead platform integration
- Inc 1 Milestone B approval is pending documentation to OSD(AT&L)



Now on The Air: Modernized Civil Signals

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- The United States initiated continuous CNAV message broadcast (L2C & L5) on 28 Apr 14; began with twice-a-week uploads and moved to daily (nominal) uploads on 31 Dec 14
 - Position accuracy not guaranteed during pre-operational deployment
 - L2C message currently set “healthy”
 - L5 message set “unhealthy” until sufficient monitoring capability established
- User-Range Error (URE) CNAV Performance Post
 - Daily uploads consistent with or exceed LNAV performance*
 - Inter-signal corrections enable single point positioning competitive with P(Y) receivers



* Data from “Performance Evaluation of the Early CNAV Navigation Message”, Pstreigenberger, O. Montenbruck, U. Hessels; Study conducted in Europe.

H O M E O F T H E



GPS
GREEN MONSTERS
To Success!!